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ABSTRACT

Seychelles Integrated Science (SIS), a 3-year laboratory-based science program for students (ages 11-15) in upper primary grades 7, 8, and 9, was developed from an extensive evaluation and modification of previous P7-P9 materials. This P8 SIS unit deals with: (1) changes in temperature which make matter expand and contract (and how this affects and can be used in students' everyday lives); (2) basic concepts in kinetic theory; (3) heat transfer and how this concept is related to everyday life in Seychelles; and (4) basic concepts in atomic and molecular theory. Provided for the unit is a student workbook and a set of teaching notes. The teaching notes include the general aims of the unit, and a lesson plan for each topic area. Each lesson plan includes a suggested time frame, a list of objectives, a list of equipment needed, and a suggested lesson format. This format includes suggestions for introducing the lesson, instructional strategies (emphasizing procedures for student activities), and evaluation methods. The student workbook includes procedures for completing the unit activities and a list of new words keyed to page numbers in the workbook. (JN)

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seychelles integrated science

Unit 10

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The Goals of Unit 10

'Heat and molecules' is the final unit of the P8 Programme. In it we deal with some quite complex, though very important, concepts about heat and heat transfer, and about the structure of matter.

Heat experiments often take quite a long time to carry out because they involve watching for and recording changes in temperature. It is especially important, therefore, that during these activities you move around from group to group asking the pupils to explain what they are doing and why they are doing it.

Unit 10 has four main goals

- 1) To make the students aware of the idea that changes in temperature can make matter expand and contract, and of how this can both affect and be used in our everyday lives.
- 2) To develop in the pupils an elementary understanding of some basic concepts in kinetic theory.
- 3) To introduce the pupils to the concept of heat transfer and to enable them to relate this concept to their everyday life in Seychelles.
- 4) To develop in the pupils an elementary understanding of some basic concepts in atomic and molecular theory.

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Some Effects of Heat

Time

Two to three periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to explain in their own words that heat can melt margarine and char (or burn) wood.
- 2) be able to use a ball and ring apparatus to show that metals expand when heated.

Equipment

Each group of pupils will need:

- a tin lid
- a burner and tripod
- a match stick and a small piece of margarine

You will need a ball and ring apparatus, a burner and some paper.

Suggested Lesson Format

Introduction

Light the burner and call one or two pupils up to the front to hold their hands in front of the flame to 'feel' the heat. Set fire to a sheet of paper and explain that the heat from the flame made the paper catch fire. Ask the pupils if anyone can suggest any other things that heat can do. Allow three or four children to make suggestions and write these on the board.

For example

Heat can burn our skin Heat can -----

Activity

Let the pupils read Section 1.1. Allow them a few minutes to discuss with their group what to do and then let each group carry out the activity. Ask one person from each group to report on what happened.

Add the two conclusions to the list of 'Things heat can do' on the board. Then get the children to write this list into their books. (objective 1).

It is likely that you will have only one ball and ring apparatus so you may need to demonstrate this activity. Try not to tell the pupils what happens or what will happen but rather describe exactly what is being done and then ask them to say what happens.

If possible get one or two of the pupils to do the demonstration rather than the technician.

Discussion & Evaluation

Afterwards ask each pupil to 'think for a moment' about what happened and then ask two or three to say why they think the ball didn't fit through the ring. During the discussion introduce the word expand. (objective 2).

Use the pupils own words to write key words or phrases on the board. The lower the stream the more you will need to write. For A streams five or six words will do but, for C & D streams you may need to write most of the sentences.

Move around checking the pupils' work and their understanding of objectives 1 and 2.

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LESSON

Unit 10

Topic 2

Expansion and Contraction

Time

Five to six periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to explain in their own words that metals expand when heated and contract (get smaller) when cooled.
- 2) be able to recognize a bar breaking apparatus and explain how it can be used to break a small bar.
- 3) be able to show that liquids expand when heated and contract when cooled, by using a boiling tube and stopper, a glass tube, some coloured liquid and a piece of paper.
- 4) be able to explain in their own words how a thermometer uses the expansion and contraction of a liquid to measure temperature.
- 5) Recall one example of how we have to make allowances for the expansion of solids e.g. loops in pipes, slackness in powerlines.

Equipment

You will need:

- a ball and ring apparatus
- a bar-breaking apparatus and some pieces of cast iron (not steel)
- a burner
- a clinical thermometer
- some dilute antiseptic

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Each group of pupils will need:

- a boiling tube and a one-hole stopper.
- a length of glass tubing to fit the stopper (a length about 10 cm)
- some coloured water.
- a thermometer
- some ice in a beaker or bowl.

Suggested Lesson Format

Introduction

Tell the pupils that you want to see how much they can remember about the different things that heat does. Allow them a moment or two to think and then use their suggestions to re-write the list from Topic 1 on the board.

Discuss what the pupils mean by 'expand' and then ask the pupils to say what they think will happen to the ball and ring apparatus when you stop heating the ball. Show the ball and ring, remind the pupils that it has 'cooled' down now and then let one or two of them check to see if the ball will fit through the ring. Introduce the word contract. (objective 1)

Activity

Show the pupils the 'second piece' of apparatus 'we will use to study expansion'. Allow as many pupils as possible to touch and handle the apparatus. Then describe what 'you' are going to do. Ask one or two pupils to suggest what they think will happen when the bar is heated. Allow the pupils to heat the bar with the burner. Give three or four the opportunity to hold the burner. (Don't let them hold the burner upside down or the flame may blow out).

Heat for 5-10 minutes. Screw the rod tight and ask the pupils to watch what you are doing and say what they think is happening. Discuss this and bring out the point that you are tightening the bar at its new 'expanded' length. Ask the pupils what do they think will happen when you stop heating the bar and the bar starts to cool down. Allow a number of pupils to make suggestions. Stop heating. Explain that you are going to use cold water to help cool the bar down quickly. Then when everyone is at a safe distance add the cold water.

Afterwards ask three or four pupils to 'explain'. Use their explanations to write either key words or a summary on the board and then get each pupil to sketch the apparatus (using the diagrams in their book) and to write out their own note or summary.

Get the pupils to read Sections 2.3, and 2.4. Allow a few minutes for each group to discuss what they are going to do and then get one group to discuss to the class what they will do. When you are sure everyone understands the instructions let each group carry out the activity. Move around from group to group asking the pupils to explain what happens and why they think it is happening.

Use their results to lead into a class discussion and write key words or phrases on the board. Get each pupil to write up a report either using the key words or completing sentences which you write on the board. (Objective 3).

Let each group look at the mercury in a thermometer as it expands and contracts during activity 2.5. Let them explain to you what happens. (objective 4).

Show how we 'use' this idea to 'search' for sick people. How we can use the thermometer to measure peoples' temperature. Check the temperature of 5 or 6 different pupils particularly any who have been ill during the past few days. (Make sure you clean the thermometer in a little dilute antiseptic between each pupil).

Discussion & Evaluation

Revise objectives 1 to 4 with the pupils. Then ask them to look at the photographs in the pupils' booklet. These photos were taken at the power station in Victoria. They show pipes with special 'Expansion joints'. Hot gases pass through these pipes and so the pipes will expand. If the engineers who built the power station did not make these special expansion joints then when the pipes became hot and expanded they would crack and the gases could kill or injure people. Where there are very long pipes sometimes they have to be set on rollers to allow them to expand. The second photograph shows a long pipe at the power station set on rollers.

Ask the pupils if they can think of any other allowance we have to make for things expanding. Telegraph wires and electricity cables often have to be set up slightly slack so that if the weather gets cold and they contract they won't get too tight and snap. (Objective 5).

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LESSON

Unit 10

Topic 3

Water and Steam

Time

Four to five periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to explain in their own words that if water becomes hot enough it boils and changes into steam.
- 2) be able to explain in their own words that it is dangerous to throw spray cans onto a fire because, the liquid in the can will expand with the heat and may explode the can.
- 3) be able to carry out an experiment and record results to show how the temperature of water (a) increases as you heat it from 30°C to boiling point and (b) remains at 100°C even though more heat is added.
- 4) know that water does not get hotter than 100°C because at that temperature, the heat changes it into steam.

Equipment

You will need a spray can (e.g a insecticide can).

Each group of pupils will need:

- a beaker (250 ml)
- the lid of a tin can which fits the top of the beaker

- some plasticine to seal the lip of the beaker.
- a burner, tripod and gauze.
- a small tin can
- a thermometer

Suggested Lesson Format

Introduction

Revise the objectives from Topic 2. In the discussion bring out the point that water expands when it is heated. Ask the pupils how much will water expand. If we keep on heating it how far can we get it to expand. Allow the pupils to discuss this with a partner for a moment and then allow two or three to make suggestions.

Activity

Tell the pupils that today we are going to try to find out how much water will expand. Let everyone read Sections 3.0 and 3.1. Show them how to set up the apparatus and then let them carry out the activity.

Move around from group to group. As the water boils in the beaker ask the members of the group to explain what is happening.. Bring out the point that the water does not keep on expanding but 'boils' and then some of the water changes into steam. (objective 1).

Let each group read 3.2 allow a few minutes for discussion and let one group describe to the class what they are going to do. Let each group carry out the activity. Ask the groups to discuss what they did and to try to give a reason why the lid 'blew off'. Allow each group to make a suggestion. From the discussion bring out the point that the water turned into steam. As more and more water became steam it 'filled up' the tin until the tin was so full it pushed or 'blew off' the lid.

Show the SPRAY CAN. Read out the warning about not placing the can on a fire. Let some of the children see this and then ask - can anyone suggest - why there is a warning. (objective 2)

Revise the Topic up to the end of Section 3.2 and during the revision write key words and phrases on the board. Then get the pupils to write a short note (or complete sentences) about what they have learned so far.

Let everyone read Sections 3.3 to 3.5. Allow a few minutes for the groups to discuss what they are going to do. You and the technician should move from group to group asking them to explain how they will carry out the activity. As each group is clear about what they are to do get them to (a) draw up a results table and (b) carry out the experiment. (objective 3)

Discussion & Evaluation

Some A classes and some good groups in B classes may be able to draw the graph by themselves. With other B classes you will have to describe how to draw the graph and sketch it on the board. The graph will probably be too difficult for C and D classes. From the discussion with these classes simply bring out objective 4. A and B classes should be able to achieve both objectives 4 and 5.

Move around from group to group as they are drawing their graphs, check what they are doing and ask individuals to explain what the results mean. Summarize the findings and get the pupils to write a sentence or two underneath their graph saying what it means.

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LESSON

Unit 10

Topic 4

Solids, Liquids and Gases

Time

Three to four periods

Objectives

At the end of the Topic the pupils should:

- 1) know that water can exist as a solid (ice) a liquid (water) and as a gas (steam).
- 2) be able to carry out an experiment and record results to show that the temperature of ice does not increase if you heat it but the ice changes (melts) into a liquid.
- 3) be able to explain in their own word that; solids have a fixed shape, liquids change their shape easily and that when liquids boil they change into a gas which can spread out from a container.
- 4) recall three solids, three liquids and three gases.

Children may have some difficulty understanding that steam is a gas. Some books refer to it as a vapour. For us a vapour is the 'gas' of a substance which at normal temperatures is either a liquid or a solid. Water vapour, and petrol vapour therefore, can be called gases.

Equipment

You will need some ice cubes and some iced cubes of coconut oil or cooking oil. Leave the oil in an ice tray in the ice-maker of a fridge overnight.

Each group of pupils will need:

- two beakers (200 or 250 ml)
- a thermometer
- some pieces of ice

You should also have a number of common materials and chemicals to demonstrate different solids, liquids and gases. e.g wood, plastic, steel, petrol, alcohol, oxygen and hydrogen and carbon dioxide. (or at least empty jars, labelled as oxygen, hydrogen and carbon dioxide).

Suggested Lesson Format

Introduction

Show the pupils some ice-cubes. Ask them 'What is ice?' Allow a few moments for discussion and bring out the point that it is frozen or 'solid' water. Now show the 'iced' oil cubes. Ask the pupils if they can guess or suggest what the cubes are made of. From the discussion bring out the point that the liquid water and the liquid oil are now both solid.

Activity

Let everyone read Section 4.1. Allow a few moments for group discussion. Listen to the suggestions from the individual groups and then let the group carry out the activity.

Let each group report to the class on what they do and what results they got.

(Each group should use a results table similar to the one for activity 3.4. Let them follow the temperature until the water reaches a temperature of about 10°C). Use the discussions to write the key words and phrases on the board and then let each pupil either write up a report or with lower streams - complete sentences using the key words. (objectives 1 and 2)

Let each group boil some water in a beaker until they can see steam coming off. Then let each examine an ice-cube, some water in a beaker, and the steam from the boiling water. Allow five minutes for discussion and ask them to prepare a (verbal) 'statement' or report about the difference between solid water (ice), liquid water, and steam.

Allow each group to report and from the discussion bring out objective 3. Let a pupil write a summary of this on the board.

Ask the pupils if they can name three solids. Write four or five suggestions on the board. Do the same thing for liquids and 'gases'.

Allow the pupils to write (or copy) the summary about solids, liquids or gases and to write into their books the names of three solids, liquids and gases.

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LESSON

Unit 10

Summary 1

Moving Molecules

Time

Two to three periods. Teachers with lower (C or D) streams may omit this summary and go on directly to Topic 5.

Objectives

At the end of the lesson the pupils should:

- 1) know that scientists believe that everything in the world is made of very tiny molecules which can move around.
- 2) know that when something gets hotter, the molecules in it start to move more.
- 3) be able to explain in their own words that the molecules of a gas move more than the molecules of a liquid and that the molecules of a liquid move more than those of a solid.

Equipment

Each group of pupils will need:

- a burner, tripod and gauze
- a beaker (as large as possible)
- a little cooking oil, 10 to 12 corns of 'popcorn'

You will need a kinetic theory model with some plastic beads or balls as model molecules.

Suggested Lesson Format

Introduction

Revise the ideas about 'things' existing as solids, liquids and gases, and introduce the word 'STATE'.

Ask the children to recall some examples of each, and to explain the difference between the three 'things'. (Objectives 1, 3 and 4 for Topic 4). Ask the pupils to describe how we get solid water to change into liquid and liquid to change into gas. Bring out the point that we have to add heat to them.

Activity

Discuss the 'idea' or theory that all (matter) solids, liquids and gases are made of tiny 'bits' or particles called MOLECULES. (Objective 1) Explain that today they are going to find out what happens to molecules when we heat them.

Let the pupils read Section 2. Explain to the pupils what you want them to do and when you are sure they understand let them carry out the activity. Move around letting each group explain to you what is happening. The idea of this activity is to help the pupils understand that when something gets hotter the molecules in it start to move more. (Objective 2)

Move from this activity directly on to the kinetic theory model. Start off with the 'molecules' in a solid - vibrating but staying in place. Then by increasing the current get the molecules to move around as in a liquid. Finally let them 'shoot off' into the air like a gas. Compare increasing the current to increasing heat.

Discussions and Evaluation

Ask the pupils to work in groups to prepare a 'statement' about the way molecules move in solids, liquids and gases.

Let each group report on their statement and then let each pupil write up his own summary based on their report.

LESSON

Unit 10

Topic 5

Conduction in a metal

Time

Three to four periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to use a steel rod and a glass rod to demonstrate that metal is a better conductor of heat than glass.
- 2) recall two examples of good conductors and two of poor conductors.
- 3) be able to carry out an experiment using a metal rod, pins and wax to show how heat is conducted along a metal bar.

Equipment

Each group of pupils will need:

- one or two glass rods and steel (metal) rods of about the same length and thickness
- a burner
- a retort stand and boss head
- a thick metal rod
- some drawing pins and wax
- a piece of cord

Suggested Lesson Format

Introduction

For this topic we suggest you 'use' activity 5-1 as the introduction.

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Let the pupils read Section 5.1. Demonstrate to them what you want them to do and then let them carry out the activity.

Activity

Move around from group to group checking on what they do. Ensure that the pupils hold the two rods at about the same distance from the flame. If possible allow two or three pupils from each group to carry out the activity using 'fresh rods'.

Allow each group a few minutes to discuss what they felt and to explain why they think it was like this. Let each group report and from the discussion bring out the idea that the heat travels 'Along' or 'through' the metal rod more easily than through the glass rod.

Let the pupils read Section 5.2, and discuss in groups what they are going to do. Let one group demonstrate to the class what they intend to do and let the others criticize and discuss. When you are satisfied everyone understands what to do let the groups carry out activity 5.2. (Objective 3).

Discussion and Evaluation

You and the technician should move from group to group checking that they carry out the activity correctly.

Allow each group a few minutes to discuss their result and to prepare a (verbal) statement about what they have learned from the result. From the discussion bring out the idea that the heat travels or is carried or conducted along the metal.

Ask the pupils to suggest two 'things' which carry or conduct heat easily and two which stop or prevent heat passing through them - poor conductors.

Let the pupils write their own verbal statements into their books - using key words or if needed, you write out one of their verbal statements' on the board. Finally get each pupils to write down the names of TWO good conductors of heat and TWO poor ones.

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LESSON

Unit 10

Topic 6

Convection

Time

Three to four periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to explain in their own words that a heat vane is turned by hot air rising from a candle (or other heat source).
- 2) be able to demonstrate convection currents in a liquid using a flask, a straw, a crystal and some water.
- 3) be able to explain in their own words that heat travels through a liquid or a gas by means of convection. i.e hot molecules of the liquid or gas rise while cold molecules fall.
- 4) be able to explain in their own words why a building should have ventilation vents high up.

Equipment

Each group will need:

- a piece of card or stiff paper
- some thread
- a burner
- use of scissors
- a retort stand, clamp and boss head.
- a flask (round bottom if available)
- straw
- a coloured crystal

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Suggested Lesson Format

Introduction

Let each group of pupils light a candle and then let each pupil hold one hand about 6 inches below the flame, then six inches to one side of the flame and finally six inches above the flame. Allow the pupils in each group a few minutes to discuss in which position the flame feels hottest and why they think this is so. Allow each group to report.

Activity

From the discussion bring out the point that it is hottest above the flame. Let the pupils read Sections 6.1, and 6.2 and then allow a few minutes for them to discuss and explain to you what they are going to do.

When you are satisfied everyone understands let each group carry out the activity.

Get each group to discuss and report on what happens and why they think it happens. From the discussion bring out objective 1 and use this to introduce the word CONVECTION. (With lower stream classes introduce the word molecules in Section 6.3 as tiny bits of AIR).

On the board write the sentence 'HOT AIR RISES.' Tell the class now they are going to do an experiment to see if heat travels in water the same way as it does in air - "to find out if hot water rises". Let everyone read Section 6.4. Allow a few minutes for discussion about what to do and then demonstrate how you want each group to carry out the experiment. Do NOT demonstrate the experiment itself. Let each group carry out the experiment.

Discussion and Evaluation

You and the technician should move from group to group asking the pupils to describe what they are doing (objective 2).

Allow each group a few minutes to prepare and report on what they 'found out' about the way heat travels in a liquid. From the discussion bring out objective 3 and write on the board. 'Hot water rises'.

Ask the pupils to read Section 6.5. And then ask each group to decide which type of vent they think should be used - A High vent or Low vent type. Let each group report on their reasons. After the discussion bring the class out to the agriculture project to see the vents in the chicken house (and pig pen if you have one). Look also at the vents in the other school buildings. (Objective 4).

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LESSON

Unit 10

Topic 7

Radiation

Time

Two to three periods

Objectives

At the end of the Topic pupils should:

- 1) know that heat can travel through places where there are no 'molecules' to either conduct or convect it and that this method of heat transfer is called radiation.
- 2) know that heat travels from the sun to the earth by radiation.
- 3) be able to set up and carry out an experiment using a black and a shiny (or white) tray and a thermometer, to show that black surfaces absorb heat better than shiny (or white) surfaces.
- 4) be able to relate their knowledge about the absorption of heat to their everyday life by explaining in their own words why the walls and roofing of a shed or poultry house should not be painted black.

Equipment

You will need 3 or 4 light bulbs and sockets for the groups of pupils to hold their hands beside.

Each group will need:

- a thermometer
- a seed tray or tin painted black
- a seed tray or tin either polished, or painted white
- some water

Suggested Lesson Format

Introduction

Revise with the pupils objectives 1 and 3 from Topic 6. Bring out the point that hot air rises.

Activity

Let the pupils read Section 7.1 and then let everyone try the activity. Ask can anyone feel heat from the bulb. Allow a few minutes for discussion and bring out the point that the heat they feel wasn't carried by convection because their hand was not above the bulb. Neither was there a solid to 'conduct' heat - so there must be a third way heat can travel. Introduce the word Radiation and bring out the point that heat can travel even when there are no 'molecules' to carry it. (objective 1).

Discuss the idea that there is no air in space, nor no metal rods, yet heat reaches us from the sun.

Get the pupils to prepare a sentence in their own words about radiation. Write the best one on the board and get the class to write it into their books.

Ask everyone to read Section 7.2. Allow each group to discuss what they are going to do and then get one group to report to the others. When you are satisfied everyone understands let the groups carry out the activity. You and the technician should move from group to group checking that they are proceeding correctly. (objective 3)

Discussion and Evaluation

Allow each group a few minutes to discuss their results and prepare a verbal report. Let each group then present their report. Summarize, one of the reports (using the pupils own words) on the board. More able pupils can then use this to write up their own report - others can fill in 'missing words' in the sentences.

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Write a question - related to objective 4 on the board. For example:

' A man has built a new poultry shed. He is going to paint the roof. Which colour do you think he should paint white or black? Give a reason for your answer'.

Let the pupils read this and then allow each group a few minutes to discuss it and prepare a verbal answer. Get each group to report on their answer.

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Heat on the move

Time

One to two periods

Objectives

At the end of the lesson the pupils should:

Be able to explain in their own words that,

- 1) heat travels through solids by conduction and the molecules of the solid 'hand on' the particles of heat.
- 2) heat travels through liquids and gases by convection and the molecules 'carry' the particles of heat with them.
- 3) heat can travel through space without needing a molecule to either 'hand on' or 'carry' the molecules of heat.

With Lower (C and D.) stream classes you may prefer to use the words 'little pieces' of solid and liquid etc.... instead of the word molecules.

Equipment

You will need three or four balls - preferably footballs.

Suggested Lesson Format

Introduction

Write the words - CONVECTION, CONDUCTION and RADIATION on the board. Ask the pupils to work in groups to discuss and prepare a 'statement' saying what we mean by each of these words and what are the differences between them.

Allow about 5 minutes for group discussion and then let 3 or 4 groups present their statements.

Activity

Bring the class outside with a number of footballs.

Give the balls to one pupils and ask if anyone could suggest how he/she could get the ball from the first pupil to a second pupil who is about ten yards away. Say that you want them to think of THREE different ways of getting the ball from pupil A to pupil B. (Throwing, kicking, heading and bouncing only count as one). Allow some discussion.

Get the pupils to form up in lines and pass the balls along the line. Explain how this compares with conduction. The 'molecules' of the solid remain in the same place but the little pieces of heat are passed from 'molecule' to 'molecule'.

Show the difference between a 'good conductor' and a 'poor' conductor' by having the pupils in one line pass two or three balls with two hands - while those in the other line are only allowed to use one hand (Objective 1). To 'show' convection get a pupil (C) to run and carry a ball from pupil (A) to pupil (B). You can bring out the idea of a convection current by getting pupil C, when he's 'lost' the heat energy of the ball, to run back 'down' to pupil A to collect a second ball etc.....

For radiation bring out the point that there are no other molecules (pupils) between pupil A and pupil B and neither of these two are allowed to carry the ball. If they throw it the bit of energy (ball) passes from A through empty space to B.

Discussion and Evaluation

Get the pupils to discuss again the differences between Conduction, Convection and Radiation. From the discussion use their words to write a summary or description of each on the board then get them to write this into their books.

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LESSON

Unit 10

Topic 8

Keeping warm, Keeping cool

Time

Four to five periods

Objectives

At the end of the Topic the pupils should:

- 1) be able to carry out an experiment using two metal cans, two beakers, lids and a thermometer to show whether (A) metal or glass jars and (B) covered or uncovered jars lose heat most easily.
- 2) explain in their own words why we should cover a pot when we are heating something in it.
- 3) know that a thermos flask can keep things either hot or cold because it prevents heat moving in or out.
- 4) be able to devise a means to 'prevent' ice from melting (i.e.. reduce the rate at which it melts), by preventing heat from reaching it.

Equipment

You will need one or two vacuum flasks for demonstration and a tea pot or coffee pot.

Each group of pupils will need:

- two metal cans
- two glass beakers (about the same size as the cans)
- two covers
- 4 measuring cylinders

For activity 8.3 you should have ice and a variety of materials available such as, news papers, sawdust and foil.

Suggested Lesson Format

Introduction

Pour some boiling water into the tea pot (or coffee pot) as if you are making tea. Ask the pupils, if they make tea how long does the tea stay warm for. Allow a few to answer and then ask 'why does it get cold?' Again allow some discussion.

Activity

Ask the pupils, "How can we keep tea warm? Is it better to keep it in the pot or pour it into the cups?"

Let everyone read Section 8.0 and 8.1. Allow each group to discuss what they are to do and then move from group to group checking that they know what to do.

Let each group carry out the activity. Afterwards let them discuss what they have learned from their results. Let each group then report on their results and from the discussion bring out objectives 1 and 2. Get everyone to write up a report on their experiment using key words or if need be completing missing words in sentences on the board.

Earlier when talking about how to keep tea warm some of the students may have mentioned the vacuum flask. Bring one out now and ask the pupils to suggest why things will stay warm in a flask. Allow a few minutes for discussion and bring out the point that the vacuum of the flask prevents heat from being lost by conduction and convection while the shiny surface helps to reduce the heat lost by radiation.

Also bring out the point that the flask can be used to keep things cold - because it also stops heat travelling in. (objective 3)

Let the pupils read Section 8.3. Allow them to put some ice in water in a vacuum flask. (Ice by itself may break the flask). Allow each group a few minutes to discuss how they could prevent ice from melting if they didn't have a flask.

Discuss with each group what they intend to do and why they intend to do it and why they think it will work. Then let each group 'try out' their suggestion

Discussion and Evaluation

Leave the activity set up for about 30 minutes then let each group look at their results and compare them with those of other groups.

Discuss which 'worked best' and ask the pupils to explain why they think it was best.
(objective 4)

From the discussion bring out the main point that to stop something from either losing or gaining heat we have to stop heat traveling in and out of the object - stop conduction, convection and radiation.

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LESSON

Unit 10

Topic 9

Atoms and molecules

Time

Four to five periods. Topic 9 is only for more academically oriented pupils, such as A and good B streams.

Objectives

At the end of the Topic pupils should:

- 1) know that substances that are made of molecules which contain atoms of only one type are called elements and that substances which are made of molecules which contain atoms of more than one type are called compounds.
- 2) recall the names of at least three elements
- 3) recognize from their names that carbon dioxide, sodium hydroxide, copper sulphate, magnesium oxide, lead nitrate and potassium iodine are compounds.
- 4) be able to carry out an experiment to prepare magnesium oxide by heating magnesium in air.
- 5) be able to make models of magnesium, oxygen and magnesium oxide molecules from plasticine
- 6) explain in their own words that when lead nitrate solution is added to potassium iodide solution a reaction takes place and two new compounds, lead iodide and potassium nitrate are formed.

BEST COPY AVAILABLE

Equipment

You will need a variety of chemical reagents - some elements, some compounds. e.g.

Zinc, iron filings, sulphur, bromine, copper sulphate, sodium hydroxide.

Each group of pupils will need:

- a burner, tripod stand and clay tri-angle (or gauze).
- a crucible with lid
- some plasticine (of at least 2 different colours).
- Two test-tubes and a test-tube rack
- about 10 ml each of lead nitrate and potassium iodide.

Suggested Lesson Format

Introduction

Write the word molecule on the board. Ask the pupils to discuss with a partner and prepare a 'statement' on what a molecule is. Allow a few minutes for discussion and then let five or six pupils make their reports.

Activity

From the pupils' reports lead into a discussion of the difference between atoms and molecules. Give a number of examples, and introduce some simple formulae. For example by saying. 'Scientists use a special language to talk or write about chemicals. They would use a special sign or symbol for oxygen. O_2 . This means that one molecule of oxygen is made up of 2 pieces or atoms of oxygen.

Go on to discuss (C , O_2 and H_2). Introduce and explain the difference between elements and compounds.

Show the class three or four labelled bottles. Ask them to say whether the chemicals are elements or compounds. Discuss their suggestions (objectives 1 and 2) and get them to write a note explaining the difference between an element and a compound. Repeat the activity with 9 or 10 different chemicals but this time get each pupil to make a 'results table' into his/her book so that they can write down the chemical name given on the bottle and then write down whether it is an element or a compound. Discuss the results with the class. (objective 3)

Get everyone to read Section 9.2. Allow each group a few minutes to discuss what they are going to do. You should check that each group is clear about what to do and then let them carry out the activity.

From the discussion bring out the point that two elements have joined together to form a compound. (objective 4).

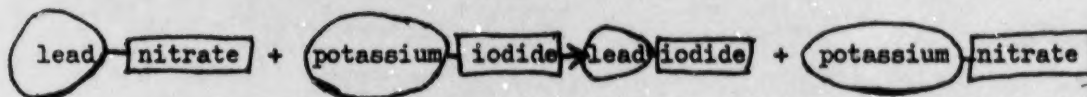
Let everyone read Section 9.3. Then ask each group to prepare 'molecules' of magnesium, oxygen and magnesium oxide using the two different colours of plasticine. You and the technician should move from group to group checking and assisting when needed.

Allow one group to demonstrate their models to the others and let them explain what each represents. Use the models to discuss the formula.



Let everyone read Section 9.4. Allow a few minutes for discussion and then let each group carry out the activity.

Afterwards ask each group to prepare a 'statement' on what has happened and ask them to suggest names for the new chemicals that have been formed. From their suggestions write a word equation on the board. (objective 6).



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SEYCHELLES
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SCIENCE

Unit 10



SE045069

HEAT AND MOLECULES

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1983

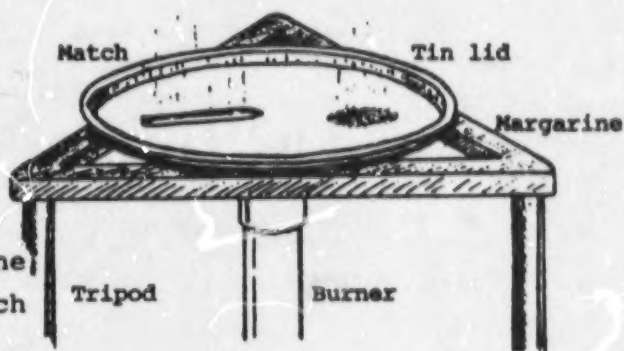
THE MINISTRY OF EDUCATION AND INFORMATION

REPUBLIC OF SEYCHELLES

SOME EFFECTS OF HEAT

- 1.0 We often talk about HEAT; for example, when we feel hot, or when we touch something hot. In this unit we are going to try and discover more about heat. For a start, discuss with your friends where you think heat comes from, and write down your answers.

- 1.1 Heat can affect things in different ways. Watch carefully what happens to a matchstick when you heat it on a small tin lid.

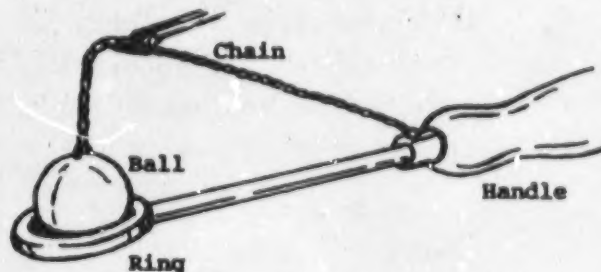


Now put a piece of margarine on the hot tin lid and watch what happens.

Describe the effect of the heat on the margarine and on the wood of the matchstick.

- 1.2 Now let's do an experiment to see what effect heat has on a metal:

First, see if you can pass the ball through the ring. Now heat the ball, but not the ring, with a gas burner. Can you pass the hot ball through the ring?



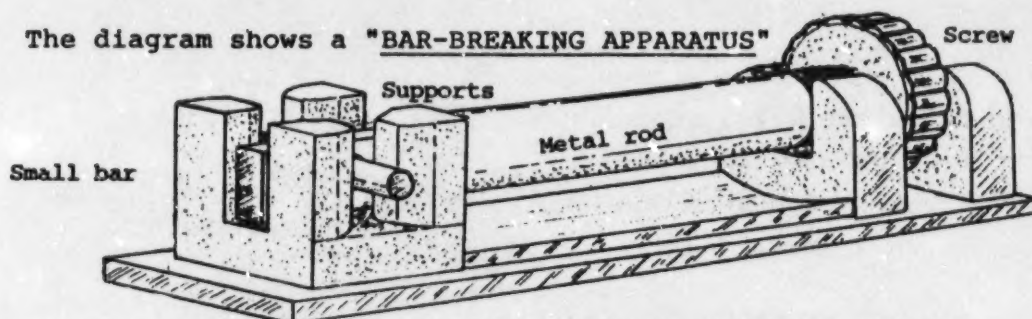
Write down what you think happened to the ball when you heated it.

- 1.3 Do you think that you will get the same result if you heat the ring but not the ball? Try it and see.

EXPANSION AND CONTRACTION

2.0 We have just learnt that if we heat a piece of metal, it gets larger, or EXPANDS. Now let us see if we can discover what happens when a piece of hot metal cools down.

2.1 The diagram shows a "BAR-BREAKING APPARATUS"



First turn the screw until the small bar is held tightly against the supports. Then heat the metal rod. As this rod gets hotter, it expands and gets longer. So, as it expands, turn the screw to keep the small bar tight against the supports.

2.2 When the metal rod will not expand any more, make sure that the screw is tight, then stop heating the rod. Stand behind the apparatus, so that the screw is closer to you than the small bar. Pour water onto the metal rod to cool it down.



In your book, describe and try to explain what happens to the small bar and to the metal rod when it cools down.

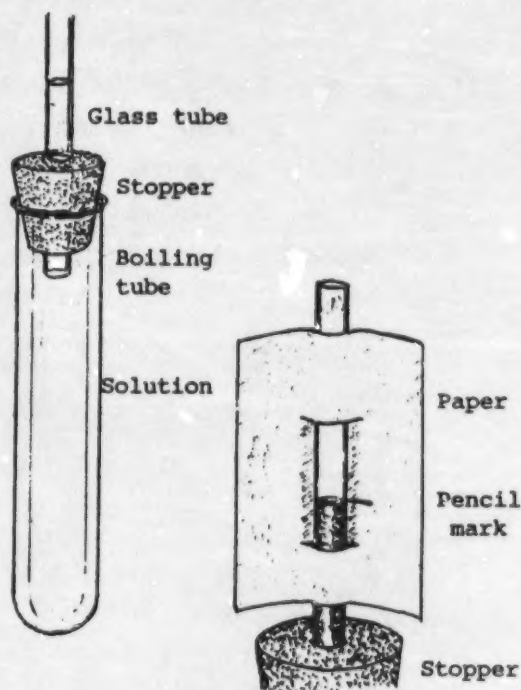
EXPANSION AND CONTRACTION

- 2.3 When we poured water onto the metal rod in experiment 2.2, it became cooler. As it became cooler, it became smaller, or CONTRACTED. As it contracted, it pulled hard on the small bar, and broke it. Now let us find out if other things such as water can also expand and contract.

Fill a boiling tube with a coloured solution. Take a stopper which has a glass tube through it, and carefully put it into the tube.

* There must be no air bubbles under the stopper.

Cut two holes in a sheet of white paper. Put the paper over the small tube, as the diagram shows. Mark the level of the coloured solution with a pencil.



- 2.4 Put the tube into a beaker of very hot water. Describe what happens to the level of the coloured solution as it gets warmer.

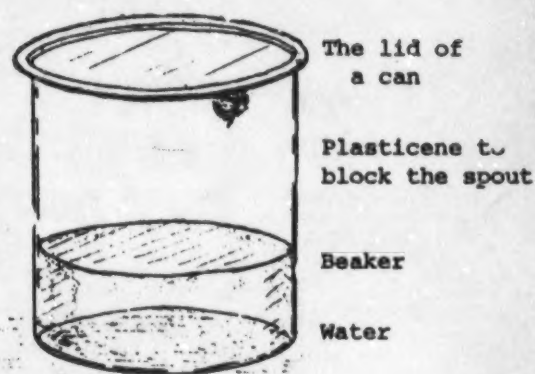
Take away the heat, and let the solution cool down. Describe what happens to the level of the solution as it cools.

- 2.5 Put a thermometer into a bowl of iced water. Then, take it out and hold the bulb of the thermometer in your hand. Describe and explain what happens to the mercury in the thermometer when you first cool it, then warm it.

WATER AND STEAM

3.0 In experiment 2.3, we learnt that water, like many other things, expands when it becomes hotter. Now let us see what happens if we heat some water more strongly.

3.1 Pour about 50 ml of water into a small beaker. Cover the top of the beaker with the lid of a can. The lid should completely cover the top. If the beaker has a spout, you should block it with a piece of plasticene.

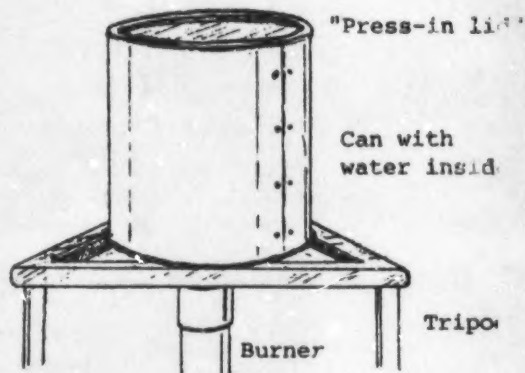


Put the beaker onto a gauze on a tripod stand, and heat it until the water boils. Describe what happens as the water boils.

3.2 In experiment 3.1, we saw that if water becomes hot enough, it boils and changes into steam. This hot steam expands and takes up more space than the water. Now let's see what happens if the steam cannot escape:

Take a small can that has a lid which you have to "press in". Pour water into the can until it is about 1 cm deep. Press the lid firmly onto the can. Put the can onto a tripod stand, and heat it with a gas burner.

****STAND AWAY FROM THE CAN****



Describe and explain what happens. Discuss why it is dangerous to throw spray cans onto a fire.

WATER AND STEAM

- 3.3 When we heat water, it gets hotter, it expands a little, and it boils. As it boils, it changes into steam, or water vapour, which expands a lot more than water. Now let us look more closely at what happens to the temperature of water when it boils.

- 3.4 Put 100 ml of water into a beaker. Draw a table into your book, like the one on the right.

Record the temperature of the water in your beaker.

TIME	TEMPERATURE
Start	30°C
After 1 minute	
" 2 "	
" 3 "	

Now heat the water with a burner, and record its temperature every minute.

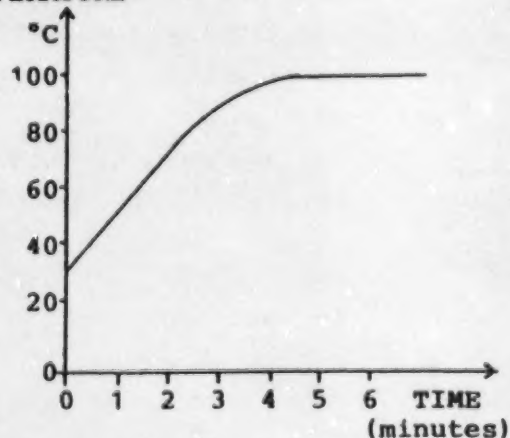
- 3.5 Continue to record the temperature every minute until the water has been boiling for at least three minutes. Use your own results to draw a graph - with "TIME" along the bottom (horizontal) line, and "TEMPERATURE" up the line at the side (the vertical axis).

Your graph may look something like the one on the right:

Use your graph to help you to describe what happens to the temperature of the water when you first heat it.

What happens to the temperature of the water while it is boiling? Try to explain this.

TEMPERATURE



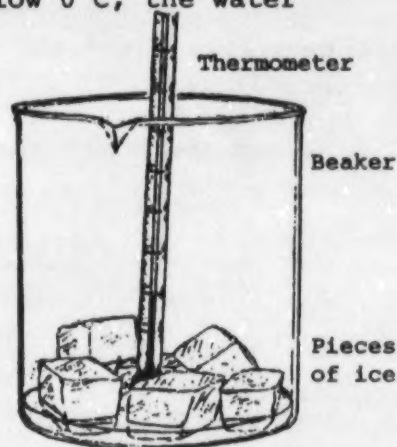
SOLIDS, LIQUIDS AND GASES

- 4.0 Water does not get hotter than 100°C , because at that temperature, the heat changes it into steam instead. Steam is a different form, or STATE, of water. With your friends, discuss how steam and water are different from one another, and write down your answers.

- 4.1 If we put some water into a very cold place, such as a "deep freeze", with a temperature below 0°C , the water becomes ice.

Look at a piece of ice. In what way is it different from water ?

Plan an experiment to find out how the temperature of some ice changes as you heat it in a beaker. In your book, describe what you do and record your results.

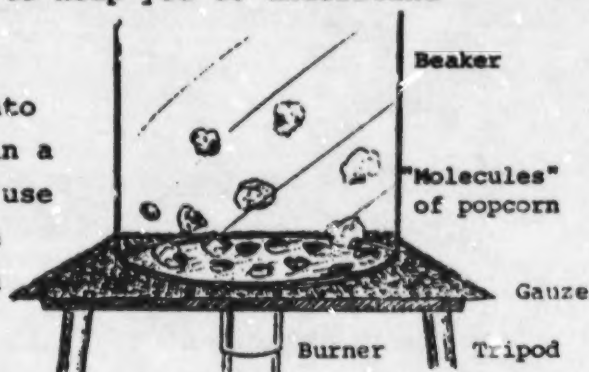


- 4.2 Ice, like steam is a different STATE of water. We say that ice is a SOLID, because it has a fixed shape. When a solid like ice melts, it loses its shape. It begins to flow, becoming a LIQUID like water. When a liquid such as water boils, it changes into a GAS like steam. The gas escapes into the air and spreads out in all directions.
- 4.3 In your book, make a list of at least five things that you think are solids like ice. Make another list of at least five liquids like water, and a third list of all the gases like steam that you know about.

MOVING MOLECULES

1. So far we have learnt that heating something can make it expand, or melt, or boil. One way for us to explain all these is to use the idea, or THEORY, that everything is made of very very tiny bits, or MOLECULES, which can move around.
2. When something gets hotter, the molecules in it start to move around more, and to take up more space. Here is an experiment which you can do to help you to understand this:

Pour a little cooking oil into a clean glass beaker. Put in a few grains of popcorn. (We use the popcorn to represent the molecules). Heat the oil in the beaker.

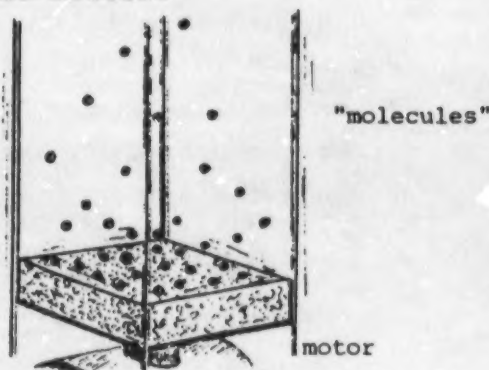


Describe what happens to the popcorn "molecules" as they get hot.

3. Your teacher will also demonstrate a machine which shows what happens to molecules as they get hotter.

In this machine, the small balls represent the molecules, and the speed of the motor represents the amount of heat that we give the molecules.

Describe what happens to these "molecules" as they get "hotter".



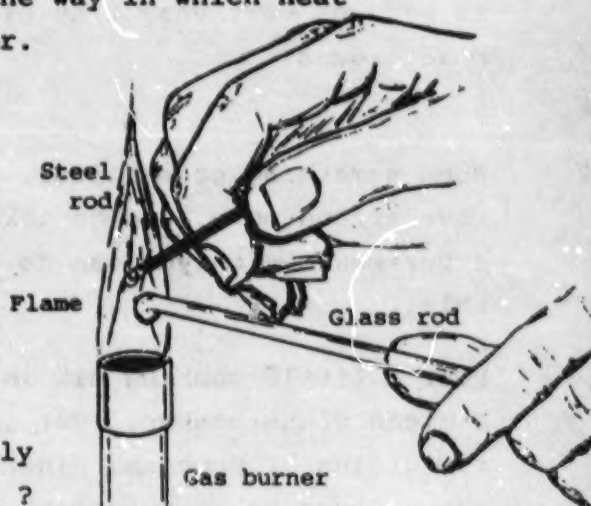
4. Write a few lines in your book to describe what you think actually happens to the molecules in something when it expands, or melts, or boils.

CONDUCTION IN A METAL

5.0 In Topics 1 - 4, we learnt about some of the ways in which heat can affect things. Now let us see if we can discover something about the way in which heat moves from one place to another.

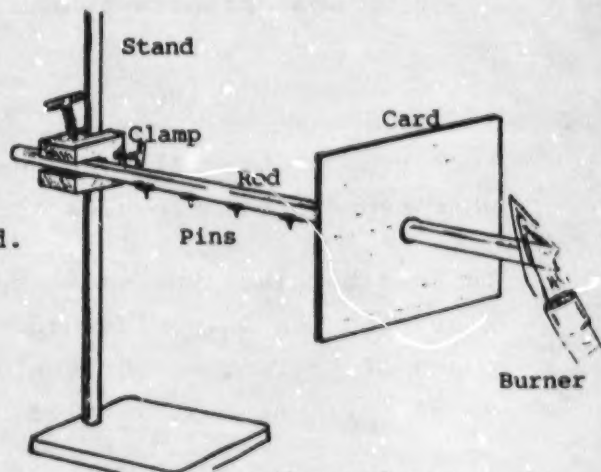
5.1 Hold a rod made of glass in your left hand, and a rod made of steel in your right hand. Put the ends of both rods into the flame of a gas burner.

For how long can you comfortably hold each of them in the flame?



5.2 Here is an experiment that shows how a metal rod gets hot:

Use a clamp and stand to hold a metal rod as the picture shows. Use some wax or margarine to attach at least three pins to the rod. Cut a hole in a square of card. Put the card on the rod about 10 cm from one end. This stops the heat from moving through the air to the pins.



Heat the end of the rod. In your book, describe and try to explain what happens to the pins as you heat the rod.

CONVECTION

6.0 In Topic 5, we learnt that heat can pass through a metal. We say that that the metal CONDUCTS the heat. Although some other things, such as glass and air, do not conduct heat very well, there are other ways by which heat can travel.

6.1 Hold your hand high above a candle flame. Slowly bring it down until you can no longer hold it there because of the heat. How far was your hand from the flame?

Now draw a "paper snake" on a piece of stiff paper or card. Cut it out, and tie some thread to the "head" of the "snake". Hold it about 15 cm above the candle flame.

Describe what happens.

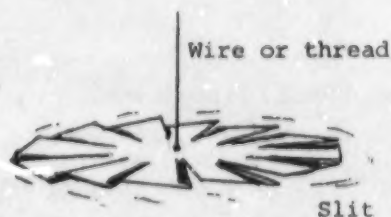


"Head" of the "snake"

Cut along the lines

6.2 You can also make a heat vane from thick metal foil:

Cut a round piece of foil about 8 cm wide. Cut a slit 2.5 cm long from the edge towards the centre. Cut a similar slit from the opposite edge towards the centre. In this way, cut 8 to 12 slits altogether all the way around.



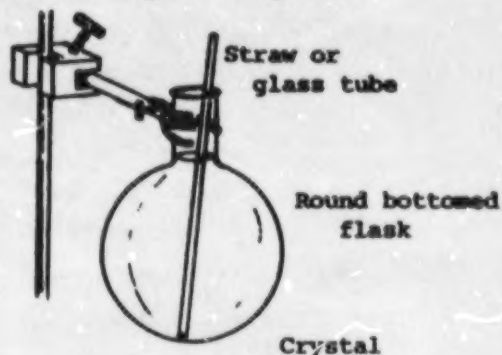
Hang your heat vane a few cm above the flame of a gas burner. Describe and try to explain what happens.

CONVECTION

6.3 In experiments 6.1 and 6.2, the hot air above the flame moved upwards, or rose, and made the paper snake and the heat vane turn around. It is the hot molecules in the air that carry the heat with them as they rise. When the molecules of something carry heat in this way, we say that the heat moves by CONVECTION.

6.4 Now let's find out if heat can move through a liquid, such as water, by convection:

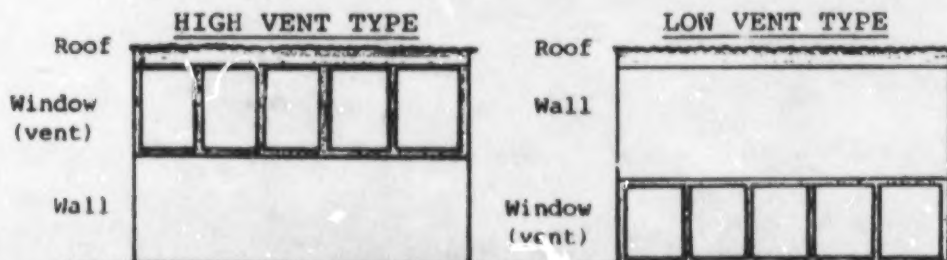
Fill a round-bottomed flask up to its neck with water. Use a clamp to hold it about 20 cm above the table. Put a long straw, or tube, into the flask so that it touches the bottom.



Drop one coloured crystal (of potassium permanganate) down the straw. Close the top of the straw with your finger, and then carefully lift it out of the flask.

Describe and explain what happens when you heat the flask very gently under the crystal.

6.5 A man building a poultry house wants to make sure that his chickens keep cool during the hot part of the day. Which of the two types of poultry house do you think he should build? Explain your choice.

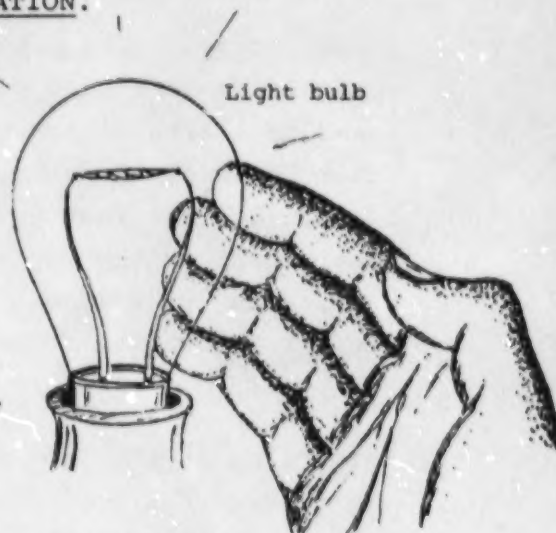


RADIATION

- 7.0 Every day the heat from the sun warms us, and everything around us. However, between the sun and the Earth, there is no metal to conduct this heat. Also there are not many molecules of liquid or gas to carry the heat by convection. Heat from the sun reaches the Earth in another way, which we call RADIATION.

- 7.1 Put your hand by the side of a light bulb, or a candle flame (NOT above it). Can you feel any heat coming from it?

Discuss whether this heat reaches your hand by conduction, convection or radiation.



- 7.2 Your hand starts to feel warm when it takes in, or **ABSORBS**, the heat coming from the bulb. Now we shall see how to compare the amounts of heat that two things can absorb:

Take two metal trays, or wide shallow tins of the same size. Paint one of them black, and polish the other until it is shiny. Pour some water into one tray until the water is about 1 cm deep.

Pour exactly the same amount of water into the other tray and leave both trays in the sunshine. After about one hour, measure the temperature in each tray. Which one absorbs more heat?



HEAT ON THE MOVE

1. We have learnt that heat can move in three different ways: by conduction, convection and radiation. Now let us try and find out exactly how the heat moves in each case.

2. First, pretend that you are a molecule in something solid. Stand in a line with about 7 other "molecules" from your class. See how fast you can pass a ball, which represents heat, along your line. You are NOT allowed to throw the ball.

A line of "molecules" in a "conductor"



Which line is the fastest conductor in your class?
(To represent a poor conductor, you can repeat this, but with everyone using only one hand to pass the "heat" along.)

3. You can also have competitions to find out who is the best "molecule" in the class at "convecting heat", and who is the best at "radiating heat".

The best at convecting will be the one who can run fastest up a slope or flight of steps with the ball.

The best at radiating heat will be the one who can throw the ball the furthest.

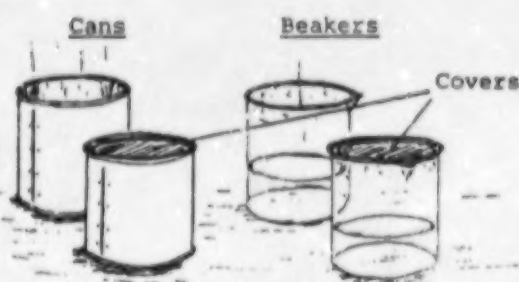
When you have finished, write a few lines to explain how you think heat actually moves in the 3 different ways.



KEEPING WARM, KEEPING COOL

8.0 Now we can use what we have learnt about heat to help keep things warm, or to help them stay cool. To keep something warm, we need to stop heat escaping from it. To make something stay cool, we need to keep heat away from it.

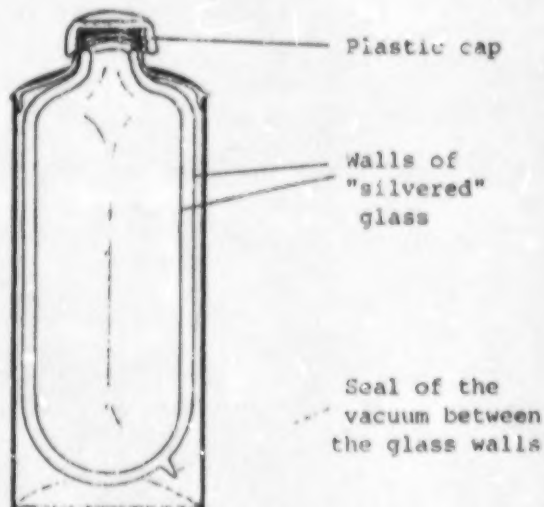
8.1 First take two glass beakers and two metal cans of about the same diameter as the beakers. Pour 100 ml of very hot water into each. Cover one of the cans and one of the beakers.



Leave all four on the table for ten minutes, then measure the temperature in each. Which stays most hot? Which cools down most quickly? Suggest reasons why this is so.

8.2 Look again at the can or beaker of water which stayed most hot in experiment 8.1. Discuss how you could make it stay even hotter.

Sometimes we use a special flask, called a "thermos" or vacuum flask to keep something hot. Look at the different parts of a vacuum flask, and write down why you think it is able to keep something hot.



KEEPING WARM, KEEPING COOL

- 8.3 We can also use a vacuum flask to make something stay cool. Put some small pieces of ice into a vacuum flask and leave it until later in the lesson.

Meanwhile, with your friends, discuss how you could stop some ice from melting, without using a "deep freeze" or a vacuum flask. You may like to plan more than one way to see which works best.

When you are ready, test your ideas with some pieces of ice. Describe how you do your tests and record your results.



- 8.4 Now go outside and do some exercises in the sunshine for ten minutes.

When you have finished, write down all of the different things that you do to help you to get cool again.

Use what you have learnt about conduction, convection and radiation to explain how doing these things helps you to cool down.



- 8.5 Now go back and look at the ice in the vacuum flask. Has it melted, or is there still solid ice inside? Explain how the flask stops the heat from outside reaching the ice inside the flask.

ATOMS AND MOLECULES

9.0 Earlier in this unit we learnt that everything is made of very tiny molecules. These molecules are made of even smaller parts which we call ATOMS. Some things are made of molecules that contain atoms of only ONE type. We call these things ELEMENTS. Others are made of molecules which contain atoms of MORE THAN ONE type. We call these things COMPOUNDS.

9.1 In Science, we call elements by a single name only. For example, oxygen, copper, hydrogen etc...

Bottles of chemicals in the laboratory:

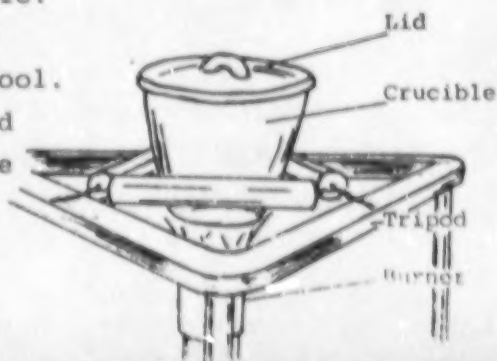
We call many compounds by a pair of names. These names tell us something about the different types of atoms in the compound. For example: carbon dioxide, sodium hydroxide, copper sulphate...



Look at the names on a number of different bottles of chemicals that are in the laboratory. Divide them into one group of elements, and another group of compounds.

9.2 Some elements will react with each other. When this happens, their atoms join together to make a compound.

Put some magnesium into a crucible. Heat the crucible quite strongly for a few minutes, then let it cool. When it is cool, look inside, and describe what has happened to the magnesium.



ATOMS AND MOLECULES

- 9.3 In experiment 9.2, the element magnesium reacted with the element oxygen in the air to make a new compound, which we call magnesium oxide. We can use different colours of plasticene to make a model which will help us to understand what has happened in this reaction:

Make several small balls, all the same size, with one colour of plasticene (for example blue). These represent atoms of the element magnesium. Stick them together, as shown in the picture:

"Magnesium atoms" joined together



Now make the same number, or more, balls of red plasticene. These represent atoms of oxygen. Stick them together in pairs to make "oxygen molecules".



"Oxygen molecule"

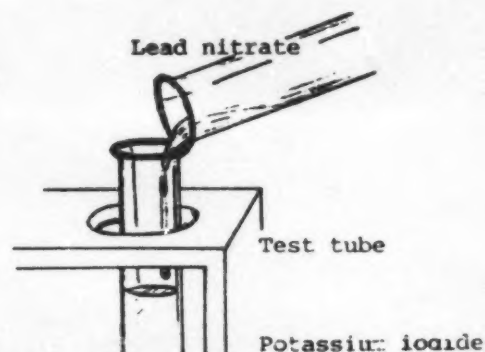


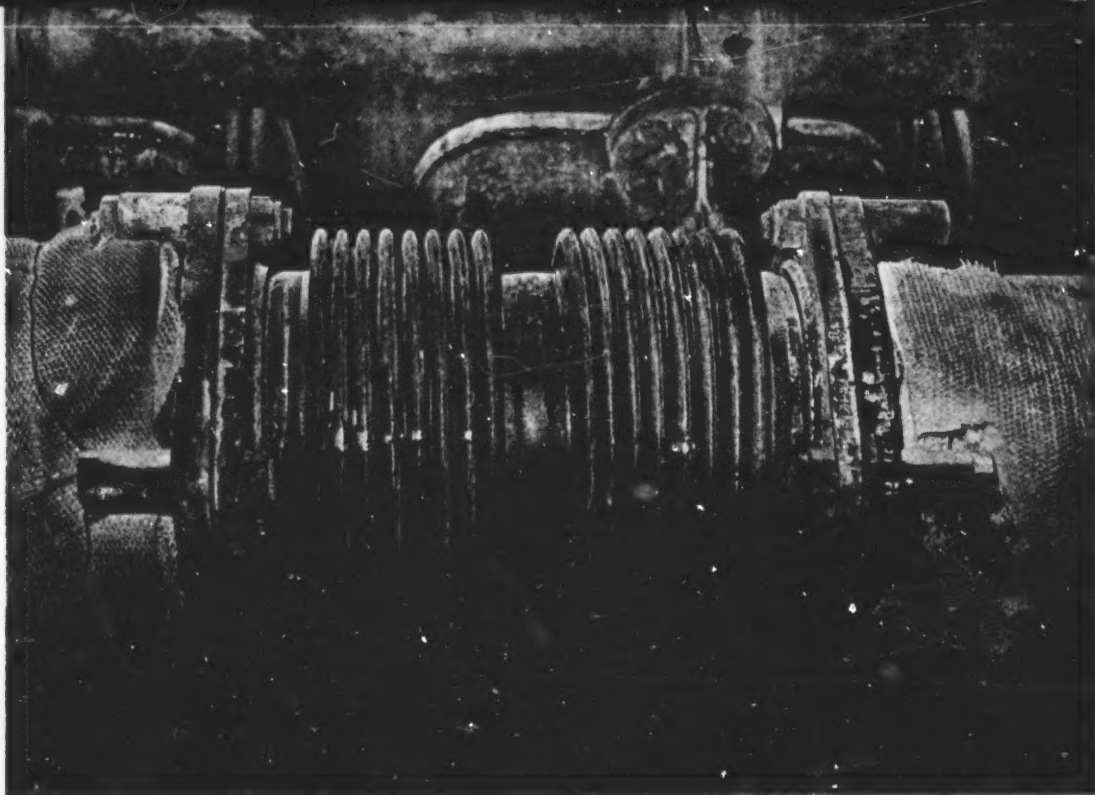
"Magnesium oxide molecule"

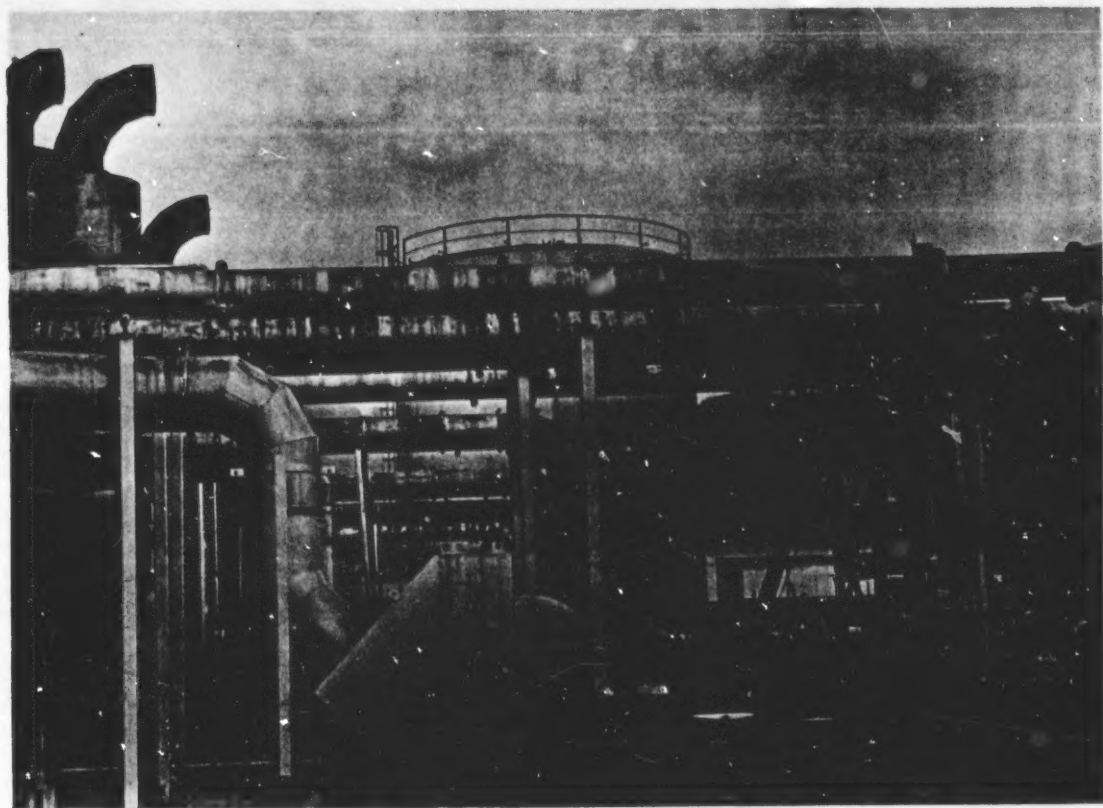
Discuss with your friends what a "molecule" of magnesium oxide should look like. Then, let your "oxygen molecules" react with your "magnesium", and change it into "magnesium oxide".

- 9.4 Compounds may also react with each other. When a compound reacts in this way, it may give, take or exchange atoms with the other compound, and produce one or more new chemicals:

Your teacher will give you solutions of two different chemical compounds in two test tubes:- lead nitrate and potassium iodide. Write down what they look like. Now add them together and describe what happens. Suggest a name for the new compound.







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